Subminiature tubes in computers

Subminiature tubes were already used in computers or in peripheral interfaces around the mid fifties, but few evidences can be found today. Probably their use was limited in airborne or military products, due to their high prices. When referring to subminiature tubes, we have to consider that they included two big families, the filamentary ones and the types with indirectly heated cathode. While the indirectly heated types could offer only a volume reduction, the filamentary ones gave further advantages as extremely low power requirements and very fast heating. I started then to look for any evidence of computers based upon subminiature tubes through the fifties. The starting points were a couple of Raytheon ads that, around the mid fifties, proposed the use of filamentary subminiature tubes in computer applications.

- Click on thumbnails to enlarge.

Raytheon claimed impressive figures for power savings when using its filamentary subminiature pentodes. Total power, filament plus B+, for 2000 tubes, equivalent to 1000 flip-flops, was about 54,5 watts for CK6418 at 30 volts and 113,5 watts for the higher speed CK6088 at 45volts. Power required to do the same job with the miniature CK5814 (12AU7) was in the order of 4700 watts.

In its second ad Raytheon shows the picture of a large mainframe, probably a Datamatic 1000. Datamatic Corporation was a joint venture between Raytheon itself and Honeywell. Unfortunately very few and contradictory details can be found today, but it is quite sure that this computer actually did not use filamentary tubes. Data available today just talk of the 6145 octal tubes (in the power supply, I guess) plus other unspecified computer-quality types. The power requirement was around 160 kW. Maybe that Raytheon used subminiature tubes in small peripheral interfaces or even that they just assembled some evaluation boards to run the life tests reported in the ad.

At the moment the only confirmed digital computer that used subminiature tubes, even if indirectly heated ones, is the Hughes Digitair, with its 481 tubes and a magnetic drum memory, designed for aircraft installations. Indeed subminiature tubes were really useful in such applications, where small size and lightweight were mandatory. Things went quite differently for other computers. Here rows of massive cabinets full of faintly glowing tubes, humming batteries of fans and even panels covered by blinking lights were certainly attractive for the few customers, military, banks or large industries that were deciding budgets of some million dollars to buy one of them. Outside of the aircraft applications we cannot believe that somebody could approve an expenditure of million dollars for something smaller than a trailer. Indeed the Mobidic was probably the first mobile computer, introduced in 1957, but it was already solid-state.

We can also argue that subminiature tubes had some drawbacks, including speed, fan-out and higher prices, for manufacturers of such mainframes. As far as I know, the only filamentary tube, widely used in mainframes well in the solid-state years, is the logic state bar indicator, like the DM160 or its American equivalent 6977.

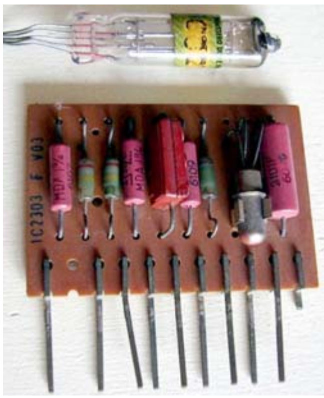
I also gave a look at the segment of analog or hybrid computers, commonly used in the fifties. In the past I found subminiature tubes in airborne analog computers, usually distributed in the many subsystems aboard. Here the photo of some modules from an ARN-52 TACAN transponder, that computes the aircraft heading and distance data with respect to a ground base, sending them to the indicator on the cockpit.

Another application using 5703 subminiature triodes in the A to D peripheral interface built by Boeing was described in this article from Electronics, August 1954.

Recently I found some samples of subminiature triodes, sealed into magnetic shielding can, the Raytheon CK-1307A. I had already seen them or something very similar many years ago, in 1966 in a junkyard among surplus material disposed by Selenia, already Microlambda an Italian spin-off of Raytheon that manufactured missiles and torpedoes. To know more, I spoke with a retired old friend who had worked since the early sixties in Selenia. Actually he was hired when old assemblies had already been replaced by solid-state ones. From his faded memories, these subminiature tubes could have been used in the guidance computer of Mark 44 torpedo, maybe as low-level amplifiers for the magnetostrictive transducer array of the active searching head.

Probably the true reason why subminiature tubes were not widely used in digital mainframes is that, in the second half of the fifties, vacuum tubes were rapidly superseded by transistors. Transistors helped to decrease production costs, while increasing computer power, registers or I/O processors. Subminiature tubes could even offer more or less similar sizes, but solid-state devices can operate cool, with a fraction of the power wasted by the tube heaters alone. Heat can be also responsible for anticipated failures or poor reliability. In one of its ads Raytheon claimed a life of 56.000 hours for its high-rel tubes. Even accepting this figure, the MTBF of a computer that hypothetically used 2.300 tubes was some 24 hours, more or less one day, not including failures of other parts. For this reason tubes quickly disappeared from the scene.

When still student, I started doing some maintenance jobs on a solid-state computer, already out of production. The Bendix / Control Data G-20, that I serviced in the late sixties at the Polytechnic of Naples, used some 5.200 germanium transistors and over than 30.000 diodes only in the CPU. Logic circuits were all based upon two-input gate modules and input expanders. At least two modules were required for each flip-flop. Here is the photo of the gate I used as sample when I was asked by the late Prof. Bruno Fadini to build some hundreds spare boards, needed to maintain the computer. I also placed a T 2x3 subminiature tube, similar to those advertised by Raytheon for computer applications, close to the board in the second view. The overall volume could be potentially more or less the same, using these tubes. But even the semiconductor technologies were advancing very quickly. The same Philco 2N501A MADT (Micro Alloy Diffused-base Transistor) germanium transistors used in the original boards and registered only in 1959 had been discontinued since the mid sixties, so I had to replace them with silicon epitaxial types.



I also found some additional examples of computers, or computer related peripherals, in which subminiature tubes were used. Anyway they refer to analog interfaces, building blocks and to airborne computers, rather than to digital mainframes. Also dedicated equipment took advantage of the reduction of power and space offered by subminiature tubes in their logic circuits, as in the case of this KWR-37 ciphering equipment

Boeing - Digital to analog computer interface, 1954

The first example is a digital to analog converter designed by Boeing in 1954. The converter accepts the binary output of a digital computer to control the angular position of a shaft, with accuracy greater than 0.1%. The interface includes a digital arithmetic unit which computes the difference between the actual position and the new position loaded from the external computer, to drive the electro-mechanical output transducer.

5703 indirectly heated subminiature triodes are used in the logic circuits.

Northrop Aircraft – Basic control modular system

In December 1955 Northrop introduced a new modular control system, based upon off-the-shelf standard modules. In this case we are referring to an analog system. Building blocks included both DC and AC amplifiers, modulator and demodulator for converting DC to AC and AC to DC, a servo amplifier, and a couple of power supply modules. Subminiature twin triodes, 6111 and 6112, were used through the low-level modules. Here is the full article from Electronics, Oct. 1957.

Epsco – Airborne digital computer

In October 1957 Electronics also talks of an airborne computer designed by Epsco. No details were given about the computer itself, since the article was focused on packaging techniques for miniaturization, but two photos show a couple of boards populated with subminiature tubes.

Edited in December 2013 by Emilio Ciardiello.